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OBSERVATIONS ON THE CULTIVATION AND DISEASES OF CABBAGE AND ONIONS IN EUROPE, 1922.

By
J. C. Walker

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OBSERVATIONS ON THE CULTIVATION AND DISEASES OF CABBAGE AND ONIONS IN EUROPE, 1922.

By J. C. Walker,
Pathologist, Bureau of Plant Industry.

Introduction

During the summer of 1922 the writer visited several European countries, including England, Denmark, Holland, France, Spain, and the Canary Islands, under the authorization of the Office of Cotton, Truck, and Forage Crop Disease Investigations, Bureau of Plant Industry, U. S. Department of Agriculture. The primary purpose of this excursion was to study the occurrence of onion and cabbage diseases in western Europe and the culture of these crops in so far as it related to the development and distribution of disease. In order that the notes thus accumulated may be of use to others particularly interested, they are presented in the present form. In must be realized that the data acquired in this hurried manner is necessarily incomplete, and the reader is therefore requested to look upon them only as travel notes, and not as an attempt at a complete compilation of facts.

I am indebted to many in each country for the cordial reception and aid extended in each case. Among this number I should mention Mr. A. D. Cotton, Dr. W. B. Brierley, and Dr. E. J. Butler in England; Dr. Carl Ferdinandsen in Denmark; Dr. H. M. Quanjer and Dr. J. Westerdijk in Holland; Dr. E. Föex and Mr. Jean Dufrenoy in France; and Dr. Gonzales-Fragoso, Señor Luis Liro, and Señor Janini Janini in Spain.

ENGLAND

Cabbage Culture in England

The climate of England is almost ideal for the culture of cabbage and its close relatives. The mild winter permits the growing of cabbage through the entire winter period, while the cool, moist summer is especially favorable. Cabbage allies are grown more commonly than in America. Cauliflower, Brussels sprouts, kohlrabi, and kale are very common crops. The list of common cabbage varieties is quite different from that used in America. Since cabbage can be planted to mature at almost any time during the year, the solid head suitable for storage and long distance shipment is unnecessary. On the other hand, the English consumer prefers cabbage cooked as a "green", and therefore much prefers a head of loosely packed green leaves to a solid white head.

Cabbage and its allies are very common in small gardens everywhere. There are a few intensive cabbage sections, however. One of these which was visited, the Evesham district in the Avon Valley, a few miles from Stratford, may serve to illustrate.

Cabbage culture is very extensive in this section. The Stokes farm which we visited is about 600 acres in extent, and about 80 acres are in cabbage. The chief crop is the spring crop. Seed is sown in seed beds from June 15 to July 15. Transplanting is being done now (September 26). The crop grows throughout the winter season and matures in February and March. The winter is more or less frosty but the varieties used are hardy enough to stand this and keep on growing. The crop is cut very early in the spring if the prices are high,--even while the heads are very small and green. The chief variety used for the spring crop is Early Evesham; Early Offenham is another common variety of the same type. These both produce heads of a loose, pointed type.

Savoy cabbage is grown here commonly as a late fall and early winter crop. The seed is sown early in the spring and transplanting is done in June or July. The two varieties most commonly used are "Best of All" and "Drumhead". The former is the earliest and is beginning to be harvested now (Sept. 26). The fields are cut two or more times. This variety is not so hardy as Drumhead and will burst readily. Drumhead matures later and will stand for an indefinite period through the winter and can be thus cut and marketed as needed.

All transplanting is done by hand here as elsewhere in Europe. The foreman on Stokes' farm says 15 expert men will pull plants and set 12 acres in a good day when watering is not necessary. With the spring crop (Early Evesham) the plants are set 9 to 10 inches apart in rows 20 to 24 inches apart. The Savoy plants are set about 15 inches apart in rows ~~y~~ 30 to 36 inches apart.

Brussels sprouts are also grown here in large acreages. Fields of these are beginning to mature now (Sept. 26). Cauliflower is also grown commonly.

Cabbage farmers here as a rule grow their own seed. With spring cabbages a few are selected at harvest (early spring), pulled out and set out in one-yard squares in an isolated place. The plants lie dormant for a while and then send up seed stems and mature seed in August, which of course can not be used until the next June. Savoys must be selected in the fall and set out during the winter. Brussels sprouts maturing during the winter will send up seed stems at once and mature seed in time to be used the following summer.

Cabbage Diseases

One is impressed by the apparent lack of diseases of serious consequence upon cabbage and allied crops in England. The climate is no doubt almost ideal for this group of plants, and a number of diseases which are very troublesome in America are held in check either by environmental conditions or cultural practices, and probably by both.

Club-root (*Plasmodiophora brassicae* Wor.) is perhaps the most common and destructive disease of cabbage in England. In the Evesham district, however, large growers were evidently avoiding serious losses by judicious rotation and generous liming.

Black-rot (*Bacterium campestre* Sm.) is hardly known. A few cases have been found, but it has seldom if ever been known to occur in serious proportions.

Downy mildew (*Peronospora parasitica*(Pers.) DeBy.) is very common but seldom of serious consequence~~s~~.

White rust (*Cystopus candidus* Pers.).--Whereas this fungus is very rare on cabbage and cauliflower in America, it does often occur on these plants in England. At times it is sufficiently abundant to be of some economic importance. (Cotton).

Black-leg (*Phoma lingam* (Tode) Desm.) is apparently totally absent.

Yellows (*Fusarium conglutinans* Woll.) has never been found.
Black leaf spot (*Alternaria brassicae* (Berk.) Sacc.) was found at Wye, but is comparatively rare.

Ring spot (*Mycosphaerella brassicicola* (DuBy.)Lindau) is very common on all forms of *Brassica oleracea*. It is of little consequence on cabbage but is sometimes destructive to cauliflower.

Turnip and Rutabaga Culture and Diseases

Rutabagas and turnips are grown extensively for stock feeding purposes throughout Lincolnshire, Yorkshire, and northward through Scotland. The clubroot is the most common disease on these crops. Professor Potter says it occurs widely in the Newcastle district and on "all types of soil". By annual liming of the soil it is reduced to a minimum. The root-rot due to *Phoma napobrassicae*, described originally by Rostrup in Denmark, was found here some years ago by Professor Potter. It has since been found in a number of places in Scotland, North Wales, and southwestern England. It appears somewhat later than September and entirely upon the root. It has not been found on leaves or stems. While not generally common, it occasionally causes heavy losses in storage. Henderson suspected this to be the same as *Phoma lingam*, but I believe it must be different.

Mr. Whitehead, Pathological Adviser for northern Wales, has made trials with the Danish strains Nos. 4 and 25 of club-root resistant rutabaga, with marked success. (See Whitehead, T. Varieties of Swedes Resistant to Finger-and-Toe. Jour.Min.Agric. (Gr. Britain) 29: No. 4, 1922.) While these varieties are not generally used as yet, these results indicate that they will be used in increasing amounts.

Turnip and Rutabaga Seed Growing

A large percentage of the seed for these crops is grown in Lincolnshire, Yorkshire, and as far south as Bedfordshire. I met a grower of this seed in the latter county in September. He told me that for the seed crop the rutabaga and turnip are sown late, i.e., in August, and when small roots have formed (not much larger than a lead pencil) the plants are transferred to the main field--about 50,000 plants to the acre. The crop remains in the ground throughout the winter and then matures seed the next July or August. The plants are cut and handled as grain and when dry they are stacked in long ricks. We saw stacks of rutabaga seed in his yard waiting to be threshed.

Mangels are handled in the same way--seed is sown in July and plants mature later than turnip the next year. We saw mangel seed still in shock. A good yield of mangel seed is 2,000 to 3,000 pounds per acre; a good yield of turnip, around 1,800 pounds. This man grows 100 to 150 acres of seed a year for Sutton & Sons, Reading. The stock seed is all furnished by the seedsman.

Onion and Leek Culture and Diseases

The onion is a common vegetable in England and is winter hardy as far north as Edinburgh. For spring bunching the seed is sown in August. The White Lisbon variety is used most commonly for this purpose. Bedfordshire is an important center for the autumn bulb crop. The seed is sown here in February or later. The plants are thinned out in May and harvested in September. A flat, light yellow variety, called Toogood's Monarch, and a light yellow globe type, called Up-to-Date, are the chief varieties. A large yellow globe, Ailsa Craig, is sometimes grown but is handled like the large yellow Spanish onion. It is sown in late summer, transplanted, and harvested the next summer. This crop is not able to compete with the Spanish crop, however.

The farmers here claim to rotate onions with other crops, and the practice is to put onions on the soil every sixth year.

The leek is a very common vegetable in English gardens. Starting from seed sown in the spring months, the plants approach maturity by autumn, but being very hardy, may stand through the winter and be taken up as used. A large leek growing section is located near Newcastle-on-Tyne.

Mildew (*Peronospora schleideni* Ung.) is one of the most common and destructive diseases of onions in England. It was found commonly on autumn-sown onions in September. According to Murphy, it survives as hibernating mycelium in some of such plants, which serve the next spring as centers of new infection.

Sclerotium

White-rot (Sclerotinia cepivorum) is widespread on onions and leek throughout the British Isles. It was found to be very destructive on young autumn-sown onions at Evesham in September. Dr. Cotton finds it common also in the spring beginning in April or May. It becomes less noticeable during the warmer weather in July.

Smut (Urocystis cepulae Frost) is not of general occurrence in England. About four centers have been found in recent years and the disease is being confined to these areas as much as possible by local quarantine. The disease is common in market gardens around Edinburgh and Glasgow.

Rust (Puccinia porri) is common, especially upon leek.

Neck-rot (Botrytis allii) in certain seasons has been very destructive after harvest. In 1922 none was to be found in the crop in Bedfordshire. Here, as in America, this disease is very spasmodic, depending upon climatic conditions.

Smudge (Colletotrichum circinans (Berk.) Vogl.)--Though this disease was first described in England by Berkeley, it has not been considered common in recent years. An interesting case of it was found at Evesham in September on August-sown White Lisbon onions about four inches high. In one spot in the field a roughly circular area a rod or more in diameter, the plants had practically all been killed. Around the edge of this area plants in various stages of the disease were found. As a rule the outer leaf became flaccid and shriveled at the soil line and the lesion advanced upward from this point and to some extent downward. Fruiting bodies of Colletotrichum developed later on the diseased tissue, both below and above ground. The fungus invaded underlying leaves successfully and eventually killed the plants. It is probable that only plants which for some reason started off slowly or were attacked very young entirely succumbed. Many plants in other parts of the field showed fruiting bodies on the base of the outer leaf or scale. Vigorously growing plants might outgrow the disease. I have never seen in America the damping off of young onion seedlings by this fungus, but under greenhouse conditions I have seen young onion seedlings readily killed off when growing in inoculated soil. Under our northern conditions the soil is very cool while the young seedling is developing and the temperature is too low for very rapid development of the fungus. Under the conditions here observed the seedlings are growing in a comparatively warm soil with plenty of moisture--conditions very similar to those in the greenhouse where killing of seedlings readily occurred.

Scale nematode (Tylenchus devastatrix)--This bulb nematode occurs to some extent though it is not considered of great importance. As a rule affected scales turn to a watery decay caused by the soft rot bacteria which follow the eel-worm.

DENMARK

Cabbage Seed-Growing in Denmark

A large percentage of Danish cabbage and cauliflower seed is grown for export, and especially for America. The industry is largely in the hands of about a dozen seed firms which as a rule deal not only in cabbage seeds but also in numerous other kinds of vegetable and grass seeds. The seed is grown on contract by individual farmers who are supplied with stock seed by the seedsman. There is also one farmers' cooperative association(Danske Landboforeningers Froforsyning, at Roskilde) which handles the cabbage seed grown by its members, and it deals in other vegetable and grass seeds as well.

Growing Regions

The larger percentage of cabbage seed is grown in the southern part of the country. Very little is grown in Jutland. Some has been grown in the past around Aarhus, but I was told by Prof. Ferdinandsen that he had inquired and learned that there was practically none there this year. The two islands, Funen and Zealand (the latter, the one on which Copenhagen is located) produce most of the cabbage seed. The small island of Amager close to Copenhagen formerly was a cabbage seed section, but is now chiefly a truck farming area. Much cauliflower seed is still grown there. On the two first mentioned islands the areas which lie fairly close to the sea are preferred. Thus, in Funen the seed which we saw was all growing along the "Great Belt" or strait near Nyborg. On the other island we saw seed growing on the other side of the strait near Slagelse and on a small peninsula near Koge, about 30 miles south of Copenhagen. These sections have the advantage of the moderating effects of the sea which makes for milder winters and cooler summers.

Methods of Handling the Cabbage-Seed Crop

There are two methods of handling the production of cabbage seed which will, for convenience, be designated as (1) the "transplanting" method and (2) the "direct sowing" method. The two will be described separately. It is possible to give the dates of sowing, etc. only very roughly, since within each method they vary widely for the different varieties. The aim is to so start the crop that the plants will reach the proper stage by late October when they are conditioned for the winter. The late varieties therefore are sown first and early varieties last.

Transplanting method.--The seed is sown in seed beds some time in May. The plants are transplanted into the field some six or eight weeks later. The plants are set at intervals of 18-32" in rows about 2-1/2 feet apart.

Heads of good size are formed by October. The plants mature sufficiently so that careful roguing is possible. In late Odtober the field is rogued and all "off-types" cut out. The loose outer leaves of remaining plants are removed and the head is cut with about four inches of the stem remaining intact below the head. A new furrow is then plowed and the heads placed upright in this trench and covered so that the top of the head is only slightly exposed. These heads are 18 to 24 inches apart in the row and the rows about four feet apart. A little soil is thrown over them for the winter. In the spring it is removed and the head cut open to make way for the growing bud.

Direct sowing method.--The seed is sown directly into the field in a continuous row or in drills. These rows are about four feet apart, sometimes less. When the plants have two to four leaves they are thinned out so as to space one plant every 15 or 20 inches in the row. This sowing is done much later than in the transplanting method--usually some time in late June or July. The plants thus are only about half grown by October and no heads are formed. Obviously no roguing whatever is possible with this method. The plants are not protected during the winter. In the spring they produce seed stems.

Merits and uses of the two systems.--It is obvious that the transplanting method is by far the more reliable of the two. It is the only one whereby an accurate estimate of the type of the mother seed plants can be made. It is the one used for the "stock seed" and to some extent for "trade seed." The direct system has only one advantage to the seedsman--it is simpler and cheaper. Early varieties especially are handled much more successfully for seed production by this system. My judgment is that this method is being used more each year and now is followed in the majority of the "trade seed" fields. It is used almost entirely for the early and medium varieties and of the five fields of late cabbage seed which I saw, two were grown by the "direct" method. This has been brought about, as one seedsman intimated, by strong competition for trade. It is to be regretted that low prices still have a decidedly greater influence in cabbage seed sales than quality and varietal purity.

System of selection and stock seed growing.--The methods of selecting and maintaining varietal purity are essentially similar to those followed by our larger American seed houses. Stock seed of each variety is produced from heads which are selected with great care as to uniformity. Such seed is grown by the firm itself or by some of their more reliable growers. The importance of careful selection for stock seed is the more necessary because with production of seed by the "direct sowing" method, roguing is not possible in the second generation.

Each seed firm which I visited had more or less extensive trial grounds in which large numbers of seed lots were being tried for varietal purity, etc. This end of the business is not unlike that of our own larger seed firms.

Isolation of fields.--The fields which I visited were all well isolated. One firm stated that they specify in contracts with growers that no other cabbage or closely allied crucifer may be grown within 600 meters of a given field; another specifies 1600 meters. The former figure is not large enough for safety. As stated above, the director of the state experiment station for field crops and plant breeding near Slagelse believes that pollen may be carried even greater distances by bees.

Growing of Yellows-Resistant Seed in Denmark

The only field of yellow-resistant seed growing in Denmark of which we learned was that owned by T. Madsen & Co. at Slagelse. This was started in 1921 from seed secured from Mr. W. S. Drummond, Racine, Wis., which, from what we know, was probably of a high grade as to quality and resistance. This field had suffered during the past winter, the stand having been reduced at least 50 per cent. The plants which were still standing were not large but well podded. The crop was grown by the "direct method". There was considerable ring-spot on leaves and stem; but no blackleg nor black-rot was found. The field was well isolated. Yield estimated at 200 kilos. (An unusually rainy period during harvest reduced this crop still more and only 40 pounds was actually secured. A trial from the lot amde in 1923 on yellows sick soil showed that the single generation removal from sick soil did not reduce the resistant quality.)

Cauliflower Seed-Growing

This crop requires much more care and skill in handling than the cabbage seed crop. It is grown mostly on the island of Amager where the farmers are equipped with greenhouses and are successful truck gardeners. The seed is sown in the fall in seed beds. The plants are transferred to pots and grown in the greenhouse through the winter months. As soon as the weather permits in the spring, the plants are reset into the open field where they produce flower stalks and seeds. The cauliflower fields were in bloom when I visited them; the cabbage seed fields had long finished blooming and were approaching maturity. The cauliflower seed does not usually mature until September. The culture of this crop is very expensive and a much more hazardous venture than the cabbage seed crop, consequently the price of Danish cauliflower seed is very much higher than that of cabbage seed. Mr. Knudson of the Hartman Company says that Holland and Italy produce a cheaper grade of cauliflower seed for America, which is handled much like the "direct" system used for cabbage. In Holland, I was also told that most of the seed produced for export was handled by the "direct system."

Occurrence of Cabbage Diseases

Ring-spot (*Mycosphaerella brassicicola*) is the most common. It is exactly similar to that which occurs on crucifers in America. The leaves, stems, and pods of cabbage seed plants often become badly spotted and in extreme cases it may reduce the yields considerably. In the fall it becomes very widespread on the young cabbage crop. Dr. Ferdinandsen has noticed during several years' observations that this disease is as a rule much more common on the seed plants which are produced by the "direct" method than on those by the transplanting method. In our current observations this was found to be true almost without exception. In the same locality, fields grown by the "transplant" method were almost completely free from ring-spot and those grown by the "direct" method were sometimes very badly diseased. Separation of the newly planted crop from the maturing seed crop is an important measure of control.

Black-leg (*Phoma lingam*).--We found no evidence of this disease in any of the seed fields visited. In the trial garden of Hartman & Company near Copenhagen a plot of red cabbage contained numerous plants decidedly stunted but not wilting. When pulled these plants showed complete decay of the fine roots and of the cortex of the stem and main root below ground. No evidence of pycnidia above ground was to be found, but in the decayed woody tissue of stem and root were many pycnidia. The size of the latter and of the spores were within the range of *Phoma lingam*. Further culture work, however, showed it to be different from our American form of *Phoma lingam*.

Aside from one other case of *P. lingam* on cauliflower in hot beds at Amager, Prof. Ferdinandsen says there is no authentic report of *Phoma lingam* in Denmark. *Phoma napobrassicae* has been found from time to time on the roots of swedes and turnips, but it is not commonly reported. This is evidently distinct from our cabbage Phoma.

The "direct" method of producing seed in Denmark is favorable for the control of *Phoma lingam*. The crowded culture of plants in the seed bed where the fungus spreads most rapidly and effectively is eliminated. This may be one reason why it has never become a serious factor there.

Black-rot (*Bacterium campestr~~i~~e*).--We found none of this disease in any of the fields visited. However, Prof. Ferdinandsen says he has seen it at times on cabbage and perhaps more often upon rutabaga and turnip. It is thus, no doubt, as we have previously found in America, liable to contaminate cruciferous crops in Denmark.

The present survey leads one to believe that the Danish fields are in general quite free from our two most serious seed-borne diseases, black-leg and black-rot. We may assume that black-leg at least is quite rare, and that black-rot is not common, though individual fields may undoubtedly become infested. For the further production of seeds in which individuals or seed firms in America may be especially interested, such as yellows-resistant strains, inspection of the seed fields for freedom from these diseases and for complete isolation is desirable.

White rust (Cystopus candidus).--We found this in one cabbage seed field near Nyborg. Lesions were common on leaves and pods, often causing considerable distortion of the latter. There was no evidence of systemic invasion of the flower parts as commonly seen on radish. It is said to be even more common on cauliflower, but we did not find it again.

Club-root (Plasmodiophora brassicae).--This disease is widespread in Denmark but evidently not of great importance in the southern provinces, which are of limestone formation. In Jutland there is much acid soil and root crops are important. Club-root is very serious in these sections. Two strains of club-root-resistant rutabagas (Nos. 4 and 25) have been selected at one of the Jutland stations and are now produced commercially. These strains have been recently introduced into Wales.

HOLLAND

Cabbage Culture and Diseases.

The Alkmaar District

This section is interesting from the agricultural standpoint. Most of Nord Hollande is below high tide level. It is protected on the west by sand dunes. A large canal protected at each end by locks or sluice gates is built from Le Helder to Amsterdam. From subsidiary canals and ditches the water is lifted by windmills or other pumps into the great canal. At low tide the sluice gates are opened and the water let out; as the tide rises the gates are shut. Most of this country is thus a series of islands three or four rods wide and 75 to 100 yards long. These are separated by canals one or two rods wide. The fertile soil is used for intensive culture of cabbage, early potatoes, onions, etc. The only access is by boat and even the horses must be taken out by boat to plow or cultivate.

Cabbage Varieties

The chief varieties used are:

(1) Winter Roode (Winter Red, Hollander type, hard, globe head, good keeper.)

(2) Vroege Roode (Early Red)
(3) Wit (Early White)
(4) Deensche Wit (Danish White, a late ballhead for storage and what we call Hollander type.)

Seed is all grown locally but little or no seed is grown other than for domestic use. In order to avoid cross pollination of the several varieties of seed grown in this small section, the farmers' associations parcel out the territory into sections within each of which only a single variety of seed can be grown. A good deal of cauliflower is also grown.

Cabbage Storage

Storage of cabbage is done in cellars or special warehouses along with potatoes. Potatoes are stored in shallow boxes but cabbage is stored in bins or stalls separated by narrow channels for ventilation. During the winter heads are selected for good keeping quality, shape, etc., and these are used for seed. Thus the plants are not pulled with roots for seed, but the cut heads are simply planted out the next spring. For commercial seed production the seed is sown later and the plants wintered over in the field.

Cabbage Diseases

This is the section in which Ritzema Bos and Quanjer worked on the Phoma disease of cabbage some fifteen years ago. It occurred then as a storage decay and also as a stem rot and wilt in the field. They did not recognize it as a seedling disease, nor as a seed-borne disease. Of recent years apparently no black-leg has been encountered and all the fields which I saw were free from this disease. Mr. van Plassche says he has not seen any of the disease in recent years, and Dr. Westerdijk later told me she had been unable to find any of the disease in Holland.

Black-rot seems also to be very rare. In the market gardens around the larger cities club-root is common but in the Alkmaar section it is not known.

On September 4, while visiting the onion and potato growing sections of the Island of Overflakkee, near Rotterdam, I found in a small garden that black-rot occurred commonly on Savoy cabbage, common white cabbage, red cabbage, cauliflower, and Brussels sprouts. Club-root was also more or less common in this section.

Commercial Cabbage Seed Production

On September 5, I visited Sluis en Groot, at Enkhuizen, a short distance northwest of Alkmaar. They grow especially flower seeds and cabbage and cauliflower seeds. Their methods of growing are quite similar to the Danish system. For trade seed the seed is sown late and the plants grow through the winter. For stock seeds the plants develop heads in the autumn. The entire plants are then pulled, piled, and covered with straw and dirt for the winter. Cauliflower seed is sown in September; the plants are carried through the winter in hotbeds and set out in the open in the spring.

I saw some indications of early marginal infection of black-rot and a little Mycosphaerella in these gardens, but no Phoma.

Onion Culture and Diseases

July observations at Alkmaar.

Onions are grown to a considerable extent in the Alkmaar region. Another important section is on the Island of Overflakkee near Rotterdam. The horticultural agent in the latter section is Mr. C. Stevens, Rykslandbounconsulent, Goes, Zealand. In both of these places onion seed is sown broadcast over the beds in April. Harvest takes place in September. Much seed is raised in Overflakkee for export, especially to England. The chief varieties are the Dutch Brown and the Zealande White. After Harvest the bulbs are stacked in the field in shallow crates and left there until sold. Many are shipped to England; last season some were imported by the United States. In the Alkmaar section we found no diseases. Dr. Westerdijk and her students had just returned from Overflakkee (July 18-19). They found in small amounts: *Sclerotium cepivorum*, *Urocystis cepulae*, *Peronospora schleideni*, *Macrosporium parasiticum*; the last two were on seed onions. It has been very dry in Holland during May and June, and mildew has started only with the recent rains. *Tylenchus devastatrix* was also found on a few onions in Overflakkee. Onion root maggots are destructive in both regions.

September observations at Overflakkee, 1922.

On September 4 I went with Dr. Westerdijk to the Island of Overflakkee, one of the group at the mouth of the Rhine, a few miles east of Rotterdam. It is a very intensive gardening center. Potatoes and onions are grown extensively; sugar beets are common; carrots are also grown to some extent. Potato Phytophthora appeared as usual this season, but did not develop very rapidly. Potatoes were being harvested. They are piled in the field and covered with straw and soil for the winter.

The onion crop for the most part was still unharvested. A yellow variety is used there entirely. Most of the seed is home-grown. The seed is sown in the spring, usually broadcast, less often in rows 8 to 10 inches apart. The bulbs are pulled when the tops fall over. They are thrown in windrows until the tops are thoroughly dry--a fortnight more or less, depending on the weather. Storage then is done in the field. The old method is to pile and cover with straw and soil. The modern method is to pile in cribs made from wire netting and cover with straw. The latter system is similar to the Spanish. The tops are not removed until after storage when the bulbs are ready to ship. They claim to have very little frost there--not sufficient to injure the onions. The practice of leaving on the tops is probably one reason why they report practically no loss in storage. With the prevailing moist weather there one would expect Botrytis to occur commonly, but Dr. Westerdijk says they have practically none of it.

Onion smut is common; the growers do not fear it, however, since it has been here a long time and is confined in severe form to only one area where onions have been grown repeatedly for several years. In general the crop is rotated with other things and the smut has not increased rapidly enough to reduce yields materially. The fact that the seed is sown broadcast may reduce the actual losses due to smut.

White rot (Sclerotium copivorum) is common but not very abundant. It was claimed to be worse than usual in 1922 after the cool, wet season. As we found it, it affected the plants which have produced good sized bulbs. The infection in most cases appeared comparatively recent. Young plants which may have been killed earlier had disappeared but there was no evidence of any marked reduction in stand due to these earlier attacks. The infection is always at thebbase of the bulb. Sometimes half of the bulb was decayed, at other times only the outer scale was affected. Growers do not consider it a serious storage rot.

Mildew (Peronospora schleideni) and leaf mold (Macrosporium parasiticum) were present to some extent on the seed onions. The mildew started earlier in the season but did not advance very rapidly.

The Tylenchus disease is evident on many onion bulbs. It is usually followed at this stage with soft rot. Certain areas in this section are avoided for onion culture because of this nematode.

Potato Diseases in Northern Holland

Mosaic troubles while of much less occurrence in this part of the country are more or less present. Many stocks are showing them this year which did not previously. Last year was unusually dry and warm, and aphids were common, leading undoubtedly to a much wider dissemination of the virus diseases.

Phytophthora infestans is just starting (July 18). It may become serious, depending on weather conditions. Spraying is practiced.

Rhizoctonia is often serious on early shoots. Mercuric chloride treatment is used commonly.

Common scab is serious at times.

Black wart is confined to one isolated area in eastern Grönigen.
Verticillium may be very serious.

FRANCE

Onion Culture

The onion is cultivated widely in France but large scale production in any one center is not common. The north coast of Brittany has a considerable acreage, some of which is exported to Great Britain. In this region the seed is sown in the autumn and the plants transplanted during the winter. This method of culture is used from this point southward, while as one goes northward from this point, spring sowing becomes the more common.

Onion Diseases

Mildew (Peronospora schleideni) occurs, its severity depending upon weather conditions. Macrosporium parasiticum commonly follows the mildew.

Smut (Urocystis cepulae Frost) has been known in France many years. As a conspicuously destructive parasite it has not attracted wide attention, however. Where transplanting is common it has probably been largely avoided. No control measures have been introduced.

White rot (Sclerotium cepivorum Berk.) was found on onion and garlic in Brittany, and also on onion bulbs in the Paris markets. It had been collected many years ago in various parts of France, but in any onion fields I visited was not known as a seriously destructive disease.

Neck-rot (Botrytis sp.) was found in the Paris markets in August.
Smudge (Colletotrichum circinans (Berk.) Vog.) was common on white varieties in the markets in August.

Bulb nematode (Tylenchus devastatrix).--According to Dr. Föex, this is reported occasionally on onions.

Seed Growing in Southern France

St. Remy de Provence, about midway between Marseilles and Avignon, is the center of a large vegetable seed growing section. There are several seed firms, some of them growing seed only for wholesale. Common vegetable seeds grown are carrots, beets, radishes, escarolle, spinach, lettuce, onions, and cabbage. The climate there, which consists of mild, rainy winters and warm, dry summers, is especially favorable to seed production.

For onion seed production the seed is sown in March; bulbs harvested in August; bulbs set out in October; seed harvested in July. The common varieties are: White Lisbon, White Barletta, Queen, jaune paille des Vertus, rose de Bonne-Garde, rouge fonce, rouge de Salon, de Madere plat. Onion seed fields were free from diseases. In some years the mildew and leaf mold are destructive.

For cabbage seed production, seed is sown in July; transplanting is done in September; the plants grow throughout the winter and seed is harvested in July. The varieties are largely French and are grown for the French and other southern European trade. The cabbage seed fields were quite healthy. The only disease found was the Alternaria leaf-spot, which was of minor importance.

SPAIN

Onion Culture at Valencia

The eastern coast of Spain from Barcelona or above to Alicante, has a narrow strip of flat alluvial soil, which is very fertile, and with the help of the water from the near-by mountains almost anything can be grown. The Valencia district extends from about Castellon to a little below Denia. Oranges are the crop of first importance; onions are second. Some 5,000,000 bushels of the latter were exported this past season (1921), of which about 2,000,000 were sent to America. There are two main crops of onions grown: the early crop, known as the "Babosa", which is a flat, white onion, a poor keeper, and is shipped mainly to nearby markets, the main export going to England; (a few go to America, but not many because of the poor keeping quality.); the late crop, known as the "Grana", which is the large yellow globe onion we are accustomed to see in our American markets. This is the principal onion crop of Valencia. From this Spanish variety our popular variety, the Prizetaker, is said to be a selection. The Babosa onion is sown in August, transplanted in December, and harvested in June and July; the Grana onion is sown in December, transplanted in April, and harvested in late July, August, and September.

Two methods of transplanting are used: (1) where there is plenty of water for irrigation, level beds are made about three yards wide, irrigated, and plants set out in rows about 12 inches apart. Irrigation is continued as necessary, but is reduced to as little as possible as soon as the plants have well recovered from the transplanting; this is done to encourage the roots to grow deeply instead of remaining near the surface of the soil; a thin mulch is kept on the surface of the soil, and weeds kept out. (2) Where water is not so prevalent, ridges are made in the field about 14 inches apart and upon each ridge two rows of plants are set about 9 inches apart and about 4-1/2 inches apart in the row. Irrigation is handled as above.

Cultivation is done mostly by hand. The fields are not large. The district is held in small areas by hundreds of peasant growers. The largest fields are seldom more than two and one-half acres in size. Practically all of the labor is done by hand and by each grower's own family.

Commercial fertilizer is used liberally; manure is avoided because of its "tendency to encourage plant diseases".

Rotation is encouraged by the agronomical engineers, and is quite generally adhered to, but not always, especially after a year of high prices. The common rotation is as follows: onions, April to September; clean culture for a few weeks; wheat planted and harvested the following June; clean cultivation June to September; sow vetch or other legume crop for forage or green manure; plow under in March; cultivate until April; plant onions.

The crop is harvested as stated above. The Babosa crop is shipped at once. The main Grana crop is shipped in part at once and the remainder is stored in cribs built much like our latticed corn cribs, where they remain until finally disposed of. The selling and packing goes on from these cribs throughout the winter. Some may be held as late as March. As a rule the American exports are pretty well over in December. There is no freezing weather at Valencia. However, there is here the opportunity for storage rots to become quite well advanced before the bulbs are packed. It thus must become a matter of proper sorting at packing time as to whether or not good stock is shipped. From what I can learn the bulbs are piled in these bins three or four or perhaps more feet deep. Moreover, the weather, while ordinarily very dry, may be very humid for several days at a time. These rainy periods are very spasmodic in the summer, but more or less common in the winter.

The reported average yields are about 500 bushels per acre, but maximum yields of 1,800 bushels have been reported. Prices vary widely according to the world supply. Last season in the early part farmers were receiving one peseta (16 cents) per box, but at the end of the season they were getting as high as 14 pes. per box. These higher figures brought in some cases as high as $2,000 return per acre.

The seed is all home grown.

Since the onions at this time (early May) have only been transplanted about four weeks, they are still quite small and quite healthy. For this reason I have not made a long stay at this time, with the idea of returning here in the latter part of July at the time when harvest is on. I have discussed matters with Mr. Janini, who is the provincial engineer, and has been in the province now for many years in this work. He is not a pathologist but has studied plant ~~d~~ diseases somewhat and is posted on the maladies of the vine. It is certain that losses in onions due to diseases have not been sufficiently noticeable to have been brought to his attention. He states that at times when a period of very moist weather occurs, the downy mildew develops very rapidly on the potato, ~~oh~~ onion, vine, and other plants, and may be very destructive if the conditions last. As a rule, however, the drying winds from the plateau serve to check the trouble very quickly. If these moist periods occur in July, or later, the soft rot and Botrytis may develop in the onion. He was not sure that he had seen Fusarium rot on the onion, but suspected that pink root did occur. The white rot, Sclerotium cepivorum, he had never heart of. I have not been able to find any clue as to its existence in Valencia.

From the American Consuls at Valencia and Barcelona the following data regarding the exports of onion and garlic to the United States from Spain have been secured:

Total Exports (to all countries)		1919	1920
Garlic,	metric tons,	5,505	6,226
	value in pesetas	2,477,291	2,801,770
Onions,	metric tons,	149,523	137,239
	value in pesetas	14,952,317	13,723,914
Exports to United States (Continental)			
From Barcelona,	onions, pounds,	641,703	-------
	garlic, pounds,	-------	-------
From Malaga,	onions, pounds,	-------	-------
	garlic, pounds,	292,285	90,927
From Valencia,	onions, bushels,	869,997	1,146,573
	garlic, pounds,	-------	181,000
From Alicante,	onions,	-------	-------
	garlic, tons,	-------	287
From Canaries,	onion seed, lbs.	69,592	61,945
	tomatoes, bushels,	-------	6,394
Exports to Porto Rico			
From Barcelona,	garlic, dollars,	386,498	209,407
From Coruna,	onions, dollars,	8,366	13,258
From Valencia,	garlic, dollars,	110,160	22,947
	paprika, dollars,	7,449	23,828
From Canaries,	onions, dollars,	23,620	43,252
From Alicante,	garlic, pounds	------	12,820

These data are compiled in a publication by the Department of Commerce, known as "Supplement to Commerce Reports--Spain."

Onion Harvesting, Packing, and Shipping at Valencia

The study of the onion crop and its diseases was continued from August 10 to 20 in the immediate vicinity of Valencia. The onion growing is centered around this city, extending for some distance to the west, slightly to the south, and roughly 10 or 15 miles to the north. The entire area where this crop is cultivated is a flat coastal plain of heavy soil which becomes very hard when not thoroughly worked. There are no large farms, the entire area being divided into small peasant holdings or "huertas" of 6 to 10 acres each.

Onions are the chief cash crop in the immediate vicinity of Valencia. The acreage this year was undoubtedly somewhat above normal, dur to the unprecedented prices of last season. The yields this season were good. As a result at this time, just after harvest, there are many onions with very little demand. Good prospects for a normal production in the United States have reduced demands from that market, and practically no onions are moving to America as yet. The exports so far are to England. One American buyer who bought heavily here last year says he will buy no onions here this season.

Harvesting

The crop has practically all been harvested. There is an occasional field still not pulled, and these are probably of ~~t~~ the latest planting. By the time the bulbs are ready to harvest, the root system is practically dead--such is the condition of onions still standing. The tops at this time are dying down but not entirely dried out. The bulbs are pulled and thrown in windrows, where they remain two, three, or four days. The tops are then cut, leaving one- to two-inch necks, which usually are still slightly succulent. The bulbs are thrown into large piles in the field and covered with the onion tops. They remain in these piles some days. If the crop is sold and to be packed at once, the bulbs are crated directly from these piles. If they are not to be packed at once, they are sorted and piled in the open shed or barranca, which is unique to this section. It is made from the stems of a native cane which are used to make the side walls. A gable roof is made from small reeds which are sealed with mud for 12 to 18 inches down from the peak. The onions remain in these bins until packed for shipping, which may be as late as February or March.

Method of Sale

The onion grower sells his crop in the field usually at harvest or in the bin. The time will vary according to the demand. The buyer in most all cases takes the crop for so many pesetas per crate in the pile or bin. He has his own packing crew, furnishes his own crates, etc. The peasant's responsibility ends when his crop is in the pile or bin. The buying is done by local Spanish or English merchants, who in turn sell to

English or American houses; or American firms buying in siffi-*cient quantity may send a representative to Valencia for the season, who buys and looks after packing and shipping. English and American buyers and Spanish, as well, each have their native "comprador," who is the intermediary between buyer and peasant. He buys under direction and superintends the packing of the crop. Women and children do the packing (See Fig. 4). It is done in the field and all decaying bulbs are thrown out at the time. Since the buyer pays only for crates of sound onions, it is to his interest to have the packing supervised carefully and all bulbs showing any evidence of decay removed.

Packs and Grades

The onions are graded as they are packed. This is all done by hand; no grading screens are used. This method was started by a local Spanish merchant, Mr. Corelli, about 20 years ago. It probably did more than anything to put the Valencian onion on a permanent footing in the world market. It is considered the best onion pack in the world and the cheapness of Spanish labor enables this section to compete favorably in this respect with any other section.

There are four standard grades of the Valencia onion, known as 3's, 4's, 5's, and 6's. These numbers refer to the number of rows of bulbs packed across the standard "case", which is about 15" square and 40" long. No 3 grade therefore are the $\not{}$ largest onions, of which only three rows can be packed. These are never packed in this case, however, but are always shipped in smaller boxes, known as a "crate", about 25" square and 8" deep, 50 bulbs to the box. The No. 4 grade takes 72 bulbs to the smaller box or four rows in the larger crate. Nos. 5 and 6 always in the larger crate, are 5 and 6 rows across, respectively. No. 4 grade is the most abundant. Nos. 5 and 6 are about the same size as our "Middle West" Yellow Globe onion. These latter grades bring a higher price in England; consequently United States gets mostly 3's and 4's. An American buyer who is on the job when he buys from a local shipper specifies in the bargain for a certain percentage of 5's and 6's. This is usually around 12 or 15 per cent of the total; otherwise he receives only 3's or 4's. The No. 3's are not considered desirable; they do not sell as readily and do not stand shipping as well as the smaller bulbs.

As the bulbs are packed, loose outer scales are removed and those bulbs showing decay are removed. Fusarium root rot, bacterial soft rot, and black mold are well recognized by the peasants and especially by the compradores.

The cost at present of the lumber, sorting, packing, hauling to the quai, and stenciling is about 4-1/2 pesetas (70 cents) per case.

Shipping

The crates are hauled in small two-wheeled donkey carts ~~or~~ over the rough roads--sometimes for many miles--to the quai at the port of Valencia. This is a large and spacious dock with abundant warehouse space. The harbor, however, is so crowded with vessels that ships are anchored some rods from the quai, and all the cargo is carried out on barges. This has the disadvantage of exposing the onion crates on the lower tier to the splashing waves. One buyer tells me that it is almost impossible to avoid wetting of a part of the cargo during this loading process. Such crates have little opportunity to dry out and of course the conditions thus become more favorable for soft rot, black mold, and probably also for Fusarium rot. Tiers of crates in the hold of the bessel are separated by narrow alleys, which facilitate air circulation. The tiers are braced with strips of lumber to prevent sliding during the voyage. It is not possible, however, to entirely eliminate the moving of the crates during rough weather.

Occurrence of Onion Diseases

The three diseases occurring upon the onions at this time were Fusarium rot, bacterial soft rot, and black mold. No Botrytis was found, and no *Sclerotium cepivorum*. It was probably a little early for Botrytis, especially since there is practically no rain at this season of the year.

Fusarium rot (culona).--This disease was found in practically every field visited. The symptoms were typical of the disease as we know it in America. It is associated more or less with maggot or other insect injury at the bases of the scales. Judging from what the peasants tell me, it may develop earlier in the season and cause the death of the plant before maturity. In most of the fields the onions had been sorted and placed in the bins. Around every such bin the ground is either strewn with decayed bulbs or the latter are thrown in a large pile near by. At this time the disease is in an early stage. The root system, as a rule, has completely disappeared and there is often evidence of Fusarium mycelium or sporulation or both at the base. In case of insect complications the decay is more advanced and bacteria are commonly present. All bulbs which show macroscopic signs of the disease are supposedly thrown out. It is evident, however, that many incipient infections are overlooked. This was shown by the fact that bulbs which I selected as free from Fusarium rot and took to France with me, after a week showed evidence of the disease. Thus we may expect the same thing to develop in the bins and in transit.

As stated above, Fusarium was found almost universally present around Valencia. From what I roughly estimate, one to five per cent of the crop is thrown out already because of Fusarium and soft rot. There is another sorting when the bulbs are removed from the bins, when even a higher percentage may be rejected. I have been told by peasants of losses of 25 to 75 per cent in the bins, but such figures are not necessarily to be taken as reliable.

Bacterial soft rot.--This is known among the peasants as "Enfermedad del cuallo," or "pichona." Where the outer fleshy scales are affected, in which case black mold usually follows, they term it "entelat" (Valenciano) or "entelado" (Spanish). This disease is considered by growers and buyers as the most destructive and most dreaded. Its occurrence here on this heavy clay soil is interesting, since from limited observation I believe it occurs in America more commonly on heavier soils. In Orange County, N. Y., where it occurs perhaps as regularly as anywhere, I have been told that it is more prevalent on the clay soil.

The infection undoubtedly takes place sometimes before and sometimes ~~a~~ during harvest. It is very difficult to detect (in America) before the onions are pulled, and since practically all the fields were past this stage here, I did not have an opportunity to observe this point. In the one or two fields still standing, a little evidence of it was noticeable, especially in connection with maggots working in the neck of the bulb. The tops of the bulbs are cut soon after pulling, when there is still some sap left in the tissues. This is favorable for dissemination of the bacteria at the time.

After the bulbs have lain in piles for about a week and are sorted over for the bins, the disease is evident. The women who work at this are quite keen in detecting these early stages. It may consist of only a slight watersoaking of one or two scales at the neck; or in more advanced cases the scales may be rotted for some distance and the watery decay can then be readily detected. One or more scales may be affected. As the rot progresses the parenchyma tissue disintegrates and small yellow patches are noticeable just beneath the epidermis. This symptom is especially distinct upon the Valencian onion. I presume it may be found to be the flavone coloring matter in the epidermal cells which has aggregated as a result of cell plasmolysis, but this is only a guess.

It is obvious that this disease is as much or more difficult to remove entirely by sorting. It is thus to be expected that more or less soft rot decay will develop in storage and transit.

One buyer (Spanish) claims that the keeping quality of the Valencian onions is determined entirely by the irrigation. The first two months and the last two months he claims are the most critical. The peasants follow a more or less orthodox system of iffigation. After the seed is planted with two irrigations at two-day intervals--then 20 days without irrigation--then irrigation every 8 days until transplanted. At transplanting plenty of water is given. Then after plants are well started, watering is stopped as long as possible to encourage deep rooting; then irrigation continued at 8-day intervals. They state that when plants "show disease, irrigation helps them to keep on growing--to shut off water would make them dry up at once." No doubt too much water during the last part of the season tends to make a larger but softer onion with a larger, more succulent neck, more susceptible to decay.

Black mold (*Nigrella*).--There was very little of this present on the onions. It was found occasionally and growers recognize it as a very serious disease, causing much damage during storage. It commonly follows soft rot and Fusarium, especially where the former affects the outer scales. Its prevalence no doubt is largely influenced by the weather. At harvest time it is usually dry, but rainy spells may come. In such weather the disease spreads very rapidly and if widely disseminated during harvest and sorting, continues to develop in storage. The method of storage is not the best, especially if the crop is not thoroughly dry when placed in the bins.

Factors Affecting Onion Diseases in Transit

One would expect from the nature of these diseases as they occur in the Valencia district that the early shipments would be the most liable to decay. The earlier the packing is done, the less the opportunity to sort out decay. In the two weeks which is the minimum to be allowed for transit to New York, soft rot can increase considerably. In lots which remain for some weeks, incipient infections have time to develop sufficiently to be detected. I believe a large percentage of the infection of Fusarium and bacteria takes place before storage and that new infections in the bin are few. Assuming this, the later the packing is done, the better it will carry. Mr. Fenger, of A. Rosenblum, Brooklyn, who bought heavily in Spain last ~~summer~~ season, says he has found this to be true. The packing and shipping continue up to December or later.

Another factor which may be noted in this regard is that of delay in shipment due to dull markets. Local buyers having bought up the bins may continue to pack without orders for shipment. This results in the bulbs standing in crates on the quay for indefinite periods. The present slow market is an example of this. The quai is filled with onion crates which are not moving. An American house then may place an order some days or weeks later and get onions packed in the early season which have stood in crates for some weeks. Thus by the time they reach New York decay may be well advanced.

Garlic Culture and Diseases

At Barcelona I learned more of the *Sclerotium cepivorum* disease from Prof. Caballero. I later visited the area where it is so common. This is in the province of Gerona, in the vicinity of a small village by the name of Banolas. The latter may not be found on every map. It lies about 40 kilometers northwest from the town of Gerona, and is accessible only by motar car. There is an extensive acreage of garlic in the neighborhood of this village; large quantities of it are exported annually. Since it is shipped either from San Palamos or Barcelona, it would be included all under Barcelona in the above table (p. 19). Evidently we did not receive any from here in the United States in 1919 or 1920, although some quantities went to Porto Rico.

The garlic crop was at the early bulbing stage when I saw it. The disease, which is known as "boixat" (bwa-chat), had already caused marked damage this season. As a rule the disease appeared in roughly circular spots in the fields. In the severely infested areas nearly all the plants had disappeared, in others the plants were just beginning to show the trouble. The symptoms above ground are yellowing of the lower leaves, the upper leaves yellow and die progressively, and finally the entire plant dries up. In the earlier stages if the plant is pulled, it comes up readily and the root system is found to have rotted off, while beginning at the base of the leaves a semi-watery decay sets in and works upward. The gray mycelium of the fungus is usually more or less evident, and the characteristic small black sclerotia appear quite early, becoming very abundant as the disease progresses. Oftentimes 50 per cent of the crop is taken.

A local veterinarian and fertilizer dealer has been interested in this disease for a number of years, and has this season several experimental plots in which he is trying the effects of application of a superphosphate, ammonium nitrate fertilizer, upon the disease. Surprisingly, he seems to be securing a marked degree of control where the fertilizer was applied. (See figure 6.)

The same disease also occurs in another section nearer Barcelona. Prof. Caballero also stated that a small amount had been reported from near Seville. In the Banolas section it has been destructive for twenty years or more. There are few onions grown at Banolas and they had been only recently planted. The local men stated, however, that about a month later there would be plenty of the disease on onions. I found a small amount in a garden containing a few early onions.

We therefore are now sure that this disease is well established in Spain in at least one section. There is no report of it in the Valencia section and if it were at all common it would come to the attention of the government men. There is some garlic raised in the Valencia district, however, and its introduction is liable to occur at any time. It undoubtedly can be as destructive on onion as upon garlic.

A later report from Senor Liro of Malaga states that the disease is common in southern Spain wherever garlic is grown. Here also the garlic crop is confined to the mountainous villages and this is the case as well in the Province of Valencia. It is probable that the garlic thrives better at a somewhat higher altitude. By contrast, the onion is produced with more success on the low coastal plains around Valencia and in northwestern

Spain in the vicinity of La Coruna.

THE CANARY ISLANDS

Onion Bulb Production

Most of the onion crop of the Canary Islands is grown on the island of Lanzarote, where the average production is about 100,000 quintals (about 200,000 bushels) per year. There is an early crop which is propagated by means of sets and matures from November to March. This is all consumed locally. The export crop is grown from seed which is sown in the autumn in seed beds, transplanted some six or eight weeks later, and harvested beginning in March and ending by the middle of last of June. I did not visit this island since the crop was entirely harvested and largely shipped before my arrival. A cargo of onions from this section was examined in the port at Santa Cruz. The Bermuda type is used entirely and practically all are of the Red and Yellow varieties. The bulbs are pulled and allowed to cure with the tops still attached. Then by a process of braiding the tops with wheat straw , they are placed in bunches of two to three dozen onions each. This is the universal method of harvesting onions in the islands, both for export and for the purpose of storage for the seed crop. It is undoubtedly a commendable practice, inasmuch as it insures a more thorough curing of the tops, sealing the necks with the least possible amount of infection. The weather is almost always free from rain during June, so that the later and perhaps larger portion of the crop is harvested during favorable weather. There is undoubtedly, however, the liability to the same diseases during transit as experienced in our southern Bermuda crop if humid weather or improper curing and handling occurs. In the Lanzarote onions examined I found in small quantities neck-rot (*Botrytis allii*) (entering through wounds), soft-rot (*Bacillus carotovorus?*) (starting at the neck of outer scales), black mold (*Aspergillus niger*), yellow rot (*Macrosporium sp.*), plenty of evidence of pink root (*Fusarium malli*), but no Fusarium bulb rot. Ordinarily the bulbs are prepared very soon for shipment by packing the bunches in hexagonal crates.

In none of these onions is any attention paid to size grades. All the onions from the very small to the very large are included without any sorting. Of course this type of pack would meet objection in the United States markets. As a matter of fact, no Canary onions are exported to the United States. The bulk of the crop goes to Cuba and Porto Rico and smaller quantities to Mexico and South American countries.

There is a smaller quantity of onions grown on the Island of La Palma. Yellow and White Bermuda varieties are grown. This crop is slightly later than that of Lanzarote, however, starting ~~lat~~ in late June or early July.

Onion Seed Production

Dates of Planting and Harvest

My own field observations were confined to the Island of Tenerife. Here practically all of the onion seed is grown and also the bulbs for the planting of the seed crop. The latter are started from seed in the autumn, transplanted some weeks later, and harvested in late June or early July. They are then stored until October, when they are planted for the production of seed. The seed crop is harvested the following year, beginning about the middle of June and continuing throughout July.

Varieties, Output, and Markets

Seed of the Bermuda varieties only is grown on the Islands. Of the three colors, the largest percentage is yellow, the next white, and the least is red. It is said that 80 to 90 per cent of the crop is exported to the United States, where it is used in our southern states and largely in Texas. Other countries taking smaller quantities are Bermuda Islands, Porto Rico, Cuba, and South America. Little or none is shipped to Europe. A summary of the exports of onion seed from the Canaries to the United States as taken from consular reports made available to me by the kindness of American Consul Henry and Vice Consul Phelan at Tenerife is as follows:

Year	Amount in pounds	Value in dollars
1909	---------	57,170
1910	---------	36,509
1911	---------	30,753
1912	---------	74,686
1913	95,516	85,578
1914	43,350[a]	45,841
1915	40,749	41,801
1916	76,487	84,387
1917	128,620	137,289
1918	94,045	--------
1919	71,630	--------
1920	63,028[b]	--------
1921	127,040[c]	142,749

(a) Red Bermuda 2,641 lbs,; Yellow, 30,786 lbs.; White, 9,923 lbs.

(b) Of these 1,083 lbs. went to Porto Rico.

(c) Of these 1,533 lbs. went to Porto Rico.

Seed Growers

Most of the seed crop is grown on contract by or for a comparatively few dealers, who sell to American seed firms or have their own agents in the States. In most cases of seed trade the consumer must depend very largely upon the reliability of the seed source and this is no less the case with the Canary onion seed. Careful selection of bulbs, proper segregation of varieties, honest labeling of seed are to be assumed only from houses with an established name; and these practices are bound to make the cost of production higher than that of the "casual buyer" who takes advantage of fluctuation in supply and demand without regard to the history and quality of the seed being handled. American users of Bermuda seed should recognize that seed from a reliable house, even though bought at a higher figure, is cheaper than seed coming through an unknown channel. There is undoubtedly a certain percentage of poorly selected bulbs planted, and I have in one case seen Yellow and White Bermuda seed growing on adjacent terraces with no attempt at isolation.

Bulb Production and Handling for Seed Growing

Most dealers grow or have grown the bulbs needed for the seed crop and distribute them to persons contracting to grow seed. It is essential for the production of reliable seed that such a practice be followed, since it is only by such methods that careful selection of bulbs can be carried on and a high-grade varietal purity be maintained. These bulbs are grown and harvested in essentially the same manner as described for the Lanzarote crop. They are then brought in in bunches to a central storage. Here they are sorted over and all bulbs having globe or bottleneck shape or off color are picked out and sold for table use. Any bulbs showing decay are also presumably discarded at this time. They are then stored by hanging the bunches upon the walls or rafters or by laying them upon the floor of the storage shed. This shed is exposed on at least one side and often the center court with a temporary roof is also used. At any rate the bulbs are protected from the sun and afforded all possible ventilation. This is very necessary, since they must be kept until October, during the hottest time of the year. One dealer, Mr. Varela, told me that he has better success by simply spreading the bulbs out upon the ground and protecting them from the sun with a canvas stretched two or three feet above them so as to afford plenty of ventilation.

While in storage the bulbs are picked over one or more times to remove decaying ones and are finally selected and sorted at planting time in October.

Handling of the Seed Crop

The seed crop is usually grown under irrigation, sometimes not. The system of planting is similar to that used in the United States. Planting of the bulbs is done in October and November.

Some of the seed is ripe by the middle of June. As soon as a very few of the seed carpels break open the entire umbel is picked and allowed to dry in the sun. Since all umbels do not ripen at once, each field is picked over several times. After the seed balls have dried out thoroughly they are thrashed by beating with a stick or flail upon a hard floor. (See fig. 16). The seed is then separated from the chaff by "hand sifting," which consists of shaking about in a broad shallow basket and allowing the wind to carry away the chaff and light seed. This is all done by the Spanish women, who become very dexterous at this operation.

The seed is grown at various points on the Island of Tenerife. The tendency at present is apparently for the industry to shift more to the south coast. This is probably due to better average yields resulting in the latter region. There appears to be less mildew on the south coast, and climatic conditions are probably largely responsible for differences between the two coasts. There are many plantings close to Santa Cruz, but the crop also occurs as far west as Anco on the south and Buena Vista on the north.

Shipping and Holding Over of Seed

Since practically all of the seed produced here is needed in August or early September for planting the Bermuda onion crop in Texas and other southern states, there can be little delay in shipping the seed as soon as it is cleaned. Dealers as a rule refuse to take seed after August 15, since this is the latest date at which shipment can be made to America for the current season's planting. The seed is all shipped in sealed tin boxes about 30 inches long, 15 inches wide, and 12 inches deep.

It is to be seen from the production figures that the supply varies greatly from year to year. This is due to various causes, such as variations in acreage planted, prevalence of disease, and seasonal conditions affecting the crop. It is consequently very often necessary to carry over a certain percentage of the crop. During the last season there was an over production and also over buying by American houses. Both facts are probably responsible for the reduction in demands reported at the opening of the 1922 shipping season.

It is well known that onion seed deteriorate very rapidly under ordinary conditions and that one-year-old seed is usually inferior to new seed. This leads to differences in disposing of the "carry-over," according to the methods and integrity of the dealer. In some cases it is held in cold storage in New York and sold the following season as new or as old seed. In other cases it is held in the Islands and thus disposed of. In either case there is no doubt that some practice ~~of~~ mixing the old and new seed and selling it all as new seed.

The carrying over of onion seed for at least one season is almost necessary to counterbalance the variations in supply and demand. At present there is a serious discrimination against one-year-old seed. If proper conditions may be found whereby deterioration may be reduced to a minimum or eliminated for one year, it should be very useful to seed dealers and should help stabilize the onion-seed market.

Onion Diseases in the Canary Islands

Since these observations were made over only a ten-day period, (June 22 to July 1), at one season of the year, their limitations are necessarily obvious. Practically no work on plant diseases has ever been done on the Islands, and no especial attention is being given to them by any agency at the present time. I was assured by some growers and dealers that there was little or no disease on the Islands, but others were aware that such was not entirely the case. With the intensive system of agriculture which is being employed, one might almost assume that some diseases were to be found; and the fact that onions and onion seed have been produced intensively for 20 years or more on these small islands would also lead one to suppose that some diseases of this crop were present. As a matter of fact, during this short stay I was able to identify, with the exception of smut and Fusarium rot, every disease known on onions in America, and one or two not known in the United States. These observations were made at the time when the bulb crop was being or had already been harvested and as the seed crop was approaching maturity. It will be best to consider each disease separately.

Mildew (Peronospora schleideni)

This, with the black leaf mold (Macrosporium parasiticum) is the most common and conspicuous disease of onions in the Canaries, and consequently the better known. I saw it in some fields at Santa Cruz (June 23 to 27) and at Orotava (June 29), where it had caused a loss of at least 80 per cent and probably more of the crop. In other fields it was much less serious and still others were quite free from it. Taken as a whole I should say that it was generally serious, but in a few cases very destructive. It was quite evident to me that the location of the fields with respect to air drainage was a very important factor in the control of this disease. In fact, wherever I saw mildew in its severe form the fields were partially surrounded either by trees or buildings, so as to prevent the freest ventilation. At Buena Vista (June 29) and Guimar (June 30) practically no mildew was found and in these cases the fields were on areas sloping toward the sea and fully exposed. Mr. Reid at Orotava has tried spraying with Bordeaux to control this disease but without success. The rows of seed plants are set somewhat closer here than in America and the difficulty of applying the spray successfully is a strong argument against its use. In fact, I believe as much or more may be gained by selection of fields and localities as by spraying. I suspect this factor accounts in part for the tendency to grow more seed each year on the south coast.

Black Leaf Mold (Macrosporium parasiticum)

This is universally present following mildew and undoubtedly increases the damage started by the latter. It probably in some cases acts independently although to a minor degree; where mildew was absent little or no leaf mold was to be found.

Rust (Puccinia porri)

This disease was made most conspicuous by the formation of telia. These developed as small pin points, closely grouped together to form black spots, irregular in size and shape, on the green seed stalk. As the stem died these spots remained equally as conspicuous. The sori, in cross section, showed the teliospores formed and closely packed together in the cells just beneath the outer epidermal cell layer. The latter, though slightly raised, was not ruptured and I believe does not rupture; the spores are probably dispersed after the death of the host or germinate in situ. The uredinia are present but not as conspicuous nor so abundant. They were seldom found to occur alone but usually with the telia. The uredinia are brown or orange in color and as they mature cause a longitudinal rupture of the host epidermis. Around these sori the telia are developed. At the time collections were made, June 24 to June 29, it was evident that uredospore formation was past and the teliospore formation had been in progress for some time. In most of the spots one uredinium was to be found in the center but it was closely surrounded and nearly obscured by the numerously crowded telia. In other cases several uredinia were found in the center of a spot, making the center light-gray with the orange uredinia and surrounded by black uredinia covering areas up to 5 mm. in diammeter and surrounded by narrow black zones of telia.

This disease was found commonly in many fields; although it was in no case abundant. In the region about Santa Cruz it was found only in fields of the Crystal Wax variety, while Yellow Bermuda fields adjacent or near by were free from it. It was thought at first to be a case of varietal difference in susceptibility. This was probably only a coincidence, however, since later (June 29) at Buena Vista the disease was found prevalent on the yellow variety. It apparently causes no serious damage to the host plant. The identity of thissfungus remains for further study.

Pink Root (Fusarium malli ?)

This disease was to be found commonly in many of the seed fields without respect to location. There was no evidence of it in anything but a mild form, however, and it is not certain that it is the same as the Texas pink root. Mr. Reid tells me that there was much more pink root two seasons ago, and Mr. Wortley speaks of it in the report of his visit of that season. It was found common on bulbs from Lanzarote Island also.

Rotation of seed fields is practiced by some growers, though it is not known how much this is done generally. The bulbs, however, being infected may be the means of carrying it to clean fields.

Basal Rot of Seed Plants

This trouble is the most serious noted on the seed crop. In some cases 90 per cent of the crop was lost. In the vicinity of Santa Cruz the Crystal Wax variety suffered the most, but near Buena Vista fields of the Yellow Bermuda were also severely affected. The disease was so far advanced that it was impossible to tell very much about the cause. The plants die down completely sometimes before much of a stem develops and more often after the blossoming stage. When pulled, the stem comes up with no resistance and the base is completely rotted off and dried up, even suggesting that it had been chewed off by rodents. The bulb, which at this stage should be of considerable size and solid, has completely decayed and usually entirely disappeared. The base of these diseased stems gives some evidence of insect working, and very often Fusarium and Botrytis are found, but it is quite possible that all of these are secondary. In a field of Yellow Bermuda at Buena Vista mostly destroyed by this type of trouble, some cases of what appears to be an earlier stage were found. (June 29). In these cases the bulbs were only partially decayed and the base of the seed stem still intact. Such bulbs were affected with bacterial soft rot. It is quite possible that most of this trouble is due to the soft-rot decay laying hold of the bulbs in midseason or later. Several of the men told me that they always had more or less of this disease causing losses during the storage period. It is necessary to follow this trouble through the season in order to tell much more about it; and it is not unthinkable that it might be traced to incipient soft rot in the bulbs before planting.

White Rot (Sclerotium cepivorum)

Two cases of this disease were found, one in Crystal Wax Bermuda just brought from the field to Mr. Reid's storage at Orotava; the other was found on the same variety under the same conditions in Mr. Wildpret's storage at Orotava. From what we know of this disease in Europe it is most common in midseason and causes the death of affected plants before harvest. Doctor Cotton states that one sees very little of it on onions in England after July. It is thus quite possible that if the fields where these infected bulbs grew were examined one or two months ago, the disease would have been found in greater abundance. Mr. Varola at Santa Cruz later told me that they often had much white rot in the bulb crop earlier in the season. It is thus no doubt prevalent to no small degree.

An important question is that of the possibility of its being carried with the seed. The chances for dissemination in such manner are not very great, although the contamination of seed through some irregular channel is not impossible. It is evident that even in cases of heavy infection in the field, few diseased bulbs reach storage. Any infected bulbs which do go thus far would decay during the warm storage period of four months, at least to such an extent that they would be thrown out as sorted before planting. However, quite healthy bulbs might carry sclerotia or infected soil to the seed field.

The disease was not found in any seed fields. In case of seed plant infection by the last possibility, the chances of the fungus contaminating the seed are not great, but of course it is not impossible. I should say the chances of seed contamination by means of Sclerotium cepivorum are quite comparable to the case of onion smut.

Smudge (Colletotrichum circinans)

Very little of this disease was found on bulbs of seed plants. On the Crystal Wax bulbs which had just been harvested, however, it was very general and in some cases very abundant. In Mr. Wildpret's storage I found in some bulbs which were only recently pulled, cases where the fungus had rapidly invaded the fleshy scales, causing much depressed lesions up to a centimeter in diameter. Mr. Wildpret says he often has considerable shrinkage in storage due to this disease. I have never seen this fungus so active on White Globe onions.

Neck Rot (Botrytis allii)

This disease though not abundant was found to occur. It was noted (June 23) on Red Bermuda bulbs recently harvested and brought from Lanzarote Island to Santa Cruz. Infection in this case had taken place through a wound on the side of the bulb. A second case was noted on Crystal Wax variety, recently harvested, at Wildpret storage, Orotava (June 30). This case was neck infection.

Soft Rot (Bacillus sp.)

A few incipient cases of what appeared to be soft rot starting at the neck and affecting outer bulbs were noted on recently harvested Lanzarote Red Bermuda onions at Santa Cruz. The occurrence of soft rot on bulbs in the seed field has already been noted.

Yellow Rot (Macrosporium sp.)

One specimen collected from a lot of Red Bermuda onions, Lanzarote, June 23.

Black Mold (Aspergillus niger)

A slight amount was found on Lanzarote Red Bermuda onions recently harvested (June 23). The weather was clear and dry as usually is the case at this season, which fact would not lead one to expect any large amount of black mold or neck rot.

Fusarium Rot

No cases of Fusarium bulb rot were noted.

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